VIIRS 375m Active Fire Science Processing Algorithm (VFIRE375_SPA) User's Guide

Version 2.5.1

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GODDARD SPACE FLIGHT CENTER
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VIIRS 375m Active Fire Science Processing Algorithm

VFIRE375_SPA

General

The NASA Goddard Space Flight Center's (GSFC) Direct Readout Laboratory (DRL), Code 606.3 developed this software for the International Polar Orbiter Processing Package (IPOPP). IPOPP maximizes the utility of Earth science data for making real-time decisions by giving fast access to instrument data and derivative products from the Suomi National Polar-orbiting Partnership (SNPP), Aqua, and Terra missions and, in the future, the Joint Polar Satellite System (JPSS) mission.

Users must agree to all terms and conditions in the Software Usage Agreement on the DRL Web Portal before downloading this software.

Software and documentation published on the DRL Web Portal may occasionally be updated or modified. The most current versions of DRL software are available at the DRL Web Portal:

http://directreadout.sci.gsfc.nasa.gov/?id=software

Questions relating to the contents or status of this software and its documentation should be addressed to the DRL via the Contact DRL mechanism at the DRL Web Portal:

http://directreadout.sci.gsfc.nasa.gov/?id=dspContent&cid=66

Algorithm Wrapper Concept

The DRL has developed an algorithm wrapper to provide a common command and execution interface to encapsulate multi-discipline, multi-mission science processing algorithms. The wrapper also provides a structured, standardized technique for packaging new or updated algorithms with minimal effort.

A Science Processing Algorithm (SPA) is defined as a wrapper and its contained algorithm. SPAs will function in a standalone, cross-platform environment to serve the needs of the broad Direct Readout community. Detailed information about SPAs and other DRL technologies is available at the DRL Web Portal.

Software Description

This software package contains the Visible Infrared Imaging Radiometer Suite (VIIRS) 375m Active Fire Science Processing Algorithm (VFIRE375_SPA). This algorithm primarily uses brightness temperatures derived from bands I04 and I05 to detect fires. The algorithm takes as input VIIRS 375m Science Data Record (SDR) files, along with the associated terrain-corrected geolocation file, and identifies active fires. Additionally, the algorithm also takes as input VIIRS M13 and IVCDB SDR files, along with the associated terrain-corrected geolocation file, for land/water mask purposes and in order to process nighttime data located over the South Atlantic Anomaly. The outputs are a two-dimensional fire mask in Hierarchical Data Format (HDF) and a fire location text file. The SPA functions in two modes: standalone, or as an IPOPP plug-in.

Software Version

Version 1.7 of the DRL algorithm wrapper was used to package the SPA described in this document. The SPA uses version 2.5.1 of the VFIRE375 algorithm.

Enhancements to this SPA include:

- land/water mask implementation in the VFIRE375 HDF outputs;
- implementation of Fire Radiative Power (FRP) in both VFIRE375 HDF and Fire Location text file outputs;
- enhanced time and geolocation attributes in the VFIRE375 HDF outputs;
- update to version 2.5.1 of the VFIRE375 algorithm.

This software will execute on a 64-bit computer and has been tested on computers with 32GB of RAM, with the following operating systems:

a) Fedora 24 X86_64;

b) CentOS Linux 7 X86_64;

c) OpenSUSE Linux 13.2 X86_64;

d) Kubuntu 14.04 X86_64.

Credits

The VFIRE375 SPA was developed by the NASA Land Science Team in collaboration with the DRL at NASA/GSFC. The software conforms with the International Land Direct Readout Coordinating Committee (ILDRCC) data requirements.

Prerequisites

To run this package, you must have the Java Development Kit (JDK) or Java Runtime Engine (JRE) (Java 1.6.0_25 or higher) installed on your computer, and have the Java installation bin/ subdirectory in your PATH environment variable. This package contains 64-bit binaries statically pre-compiled on an x86-compatible 64-bit computer running under CentOS 7, using gcc 4.5.1.

Program Inputs and Outputs

The VFIRE375 algorithm takes as input VIIRS I01, I02, I03, I04, I05, M13, and IVCDB SDRs, and I-band and M-band terrain-corrected geolocation HDF5 files. The algorithm outputs the VIIRS 375m Active Fires HDF file and the Fire Location text file.

The Fire Location 375m text file is output when fire detections are present in the VFIRE375 HDF output. This text file contains information about each fire pixel detected by the SPA. Each line represents one fire pixel and has the following seven columns, separated by commas, for example:

22.86469,-81.37183,367.0,0.4,0.4,7,78.7

The table below describes each column in detail. The information contained in this table was obtained from http://viirsfire.geog.umd.edu/pages/iband.php and from the vfire375_users_guide.pdf file packaged with the VFIRE375_SPA.

Column Number	Column Description	Units	Possible Values
1	Fire pixel latitude	Degrees	Range: -90.00000 to 90.00000
2	Fire pixel longitude	Degrees	Range: -180.00000 to 180.00000
3	Fire pixel channel I4 brightness temperature	Kelvin	Range: 208 to 367 Brightness temperature values from channel I4. There is a typical saturation condition where the fire pixel is assigned the nominal saturation temperature of 367 K. Also, there are extreme cases where a fire detection will greatly exceed the resolvable brightness temperature in channel I4, causing the fire pixel's Digital Number (DN) to fold over and show an abnormally low temperature which can be confronted by the companion long-wave infrared channel I5 data.
4	Fire pixel size along the scan nadir	Kilometers	Range: 0.3 to 0.8, for both along the scan nadir and along the track nadir. Fire pixel size is a function of scan angle from nadir: At 0 (nadir) to ±31.59 degrees scan angle, three native pixels are aggregated over the radiance domain to form one effective sample. In the second image section extending from ±31.59 to ±44.68 degrees scan angle, two native pixels are aggregated to form one effective sample, and finally in the third image section extending from ±44.68 degrees to the maximum scan angle (±56.06 degrees), no aggregation is performed and one native pixel represents one effective sample.
5	Fire pixel size along the track nadir	Kilometers	
6	Fire pixel detection confidence	n/a	7 = Low confidence fire pixel. During daytime, these are typically due to areas of sun glint and lower relative temperature anomalies (< 15K) in the mid-infrared channel I4. During nighttime, these only occur over the region of the South Atlantic Magnetic Anomaly (from 11°E to 110°W and 7°E to 55°S), which can cause spurious brightness temperatures in the mid-infrared channel I4 and lead to potential false alarms. 8 = Nominal confidence fire pixel. These are free of potential sun glint during daytime, and marked by strong (> 15K) temperature anomalies in either

			daytime or nighttime. 9 = High confidence fire pixel. In both daytime and nighttime, these are saturated pixels which include nominal saturation and DN folding (i.e., pixels that greatly exceed the saturation temperature causing the DN value to fold over).
7	Fire pixel radiative power	Megawatts	Variable: non-zero positive floating-point value (> 0.0 MW). Fire Radiative Power (FRP) is a measure of the rate of radiant heat output from a fire. It has been demonstrated in small-scale experimental fires that the FRP of a fire is related to the rate at which fuel is being consumed and smoke emissions released.

Please note that the Fire Location text file is not generated if no fire pixels are detected for the datasets processed. When running in Standalone Mode, the VFIRE375_SPA will terminate with a message similar to the following when no Fire Location text file is generated:

Output viirs.activefires375 is /home/ipopp/drl/SPA/VFIRE375/testdata/output/VF375.hdf

Output viirs.fireloc375 is null

Installation and Configuration

Installing as a Standalone Application:

Download the VFIRE375_2.5.1_SPA_1.7.tar.gz and
VFIRE375_2.5.1_SPA_1.7_testdata.tar.gz (optional) files into the same directory.

Decompress and un-archive the VFIRE375_2.5.1_SPA_1.7.tar.gz and
VFIRE375_2.5.1_SPA_1.7_testdata.tar.gz (optional) files:

```
$ tar -xzf VFIRE375_2.5.1_SPA_1.7.tar.gz
$ tar -xzf VFIRE375_2.5.1_SPA_1.7_testdata.tar.gz
```

This will create the following subdirectories:

```
SPA
    VFIRE375
        algorithm
        ancillary
        station
        testdata
        testscripts
        wrapper
```

Installing into an IPOPP Framework: This SPA can also be installed dynamically into an IPOPP framework to automate production of VIIRS 375m Active Fires and Fire Location text file data products. The SPA installation process will install its SPA service(s) into IPOPP. An SPA service is an IPOPP agent that provides the mechanism necessary for running an SPA automatically within the IPOPP framework. Once this SPA is installed, users must enable the SPA service(s) corresponding to this SPA along with any other prerequisite SPA service(s). Instructions for installing an SPA and enabling its services are contained in the IPOPP User's Guide (available on the DRL Web Portal). The SPA services associated with this SPA are listed in Appendix A.

Software Package Testing and Validation

The testscripts subdirectory contains test scripts that can be used to verify that your current installation of the SPA is working properly, as described below. Note that the optional VFIRE375_2.5.1_SPA_1.7_testdata.tar.gz file is required to execute these testing procedures.

Step 1: cd into the testscripts directory.
Step 2: There is a script named run-VFIRE375.sh inside the testscripts directory. To run the VFIRE375 algorithm, use

```
$ ./run-VFIRE375.sh
```

A successful execution usually requires 1 minute or more, depending on the speed of your computer and the size of the input. If everything is working properly, the scripts will terminate with a message such as:

```
Output viirs.activefires375 is /home/ipopp/drl/SPA/VFIRE375/testdata/output/VF375.hdf
Output viirs.fireloc375 is /home/ipopp/drl/SPA/VFIRE375/testdata/output/FireLoc375.txt
```

You can cd to the output directory to verify that the science products exist. Test output product(s) are available for comparison in the testdata/output directory. These test output product(s) were generated on a 64-bit PC architecture computer running CentOS 7. The output products serve as an indicator of expected program output. Use a comparison utility (such as diff, hdiff, etc.) to compare your output product(s) to those provided in the testdata/output directory. Locally generated files may differ slightly from the provided output files because of differences in machine architecture or operating systems.

If there is a problem and the code terminates abnormally, the problem can be identified using the log files. Log files are automatically generated within the directory used for execution. They start with stdfile* and errfile*. Other log and intermediate files may be generated automatically within the directory used for execution. They are useful for traceability and debugging purposes. However it is strongly recommended that users clean up log files and intermediate files left behind in the run directory before initiating a fresh execution of the SPA. Intermediate files from a previous run may affect a successive run and produce ambiguous results. Please report any errors that cannot be fixed to the DRL.

Program Operation

In order to run the package using your own input data, you can either use the run scripts within the wrapper subdirectories, or modify the test scripts within the testscripts subdirectory.

To Use the Run Script

Identify the 'run' script: The wrapper directory within this package contains one subdirectory named VFIRE375. The subdirectory contains an executable called 'run'. Execute 'run' within the correct wrapper subdirectory to generate the corresponding product. For instance, the 'run' within wrapper/VFIRE375 is used for creating VFIRE375 outputs. Note that to execute 'run', you need to have java on your path.

Specify input parameters using <label value> pairs: To execute the 'run' scripts, you must supply the required input and output parameters. Input and output parameters are usually file paths or other values (e.g., an automatic search flag). Each parameter is specified on the command line by a <label value> pair. Labels are simply predefined names for parameters. Each label must be followed by its actual value. Each process has its own set of <label value> pairs that must be specified in order for it to execute. The two types of <label value> pairs that the VFIRE375_SPA uses are:

a) Input file label/values. These are input file paths. Values are absolute or relative paths to the corresponding input file.

b) Output file label/values. These are output files that are produced by the SPA. Values are absolute or relative paths of the files you want to generate.

The following tables contain labels, and their descriptions, required by the VFIRE375_SPA.

Input File Labels	Description	Source
viirs.gitco	VIIRS I-Band Terrain-Corrected Geolocation input HDF file path	1. The C-SDR_SPA may be used to create these products. 2. Real time products over the eastern US region are available from the DRL ftp site at: ftp://is.sci.gsfc.nasa.gov/gsfcdata/npp/viirs/level1/<GITCO|SVIxx|GMTCO|SVM13|IVCDB>_npp _dyyyymmdd_thhmmssS_ehhmmssS*.h5 Where yyyy, mm, dd represents the year, month, and day of month for the start of the swath; the first hh, mm, ss, S represents the hour, minutes, seconds, and 10th of a second for the start of the swath and the second hh, mm, ss, S represents the end time of the swath. (xx = 01 to 05) 3. VIIRS I-Band SDR, I-Band Terrain-Corrected Geolocation, M-Band SDR, and M-Band Terrain-Corrected Geolocation
viirs.svi01	VIIRS 375m I01 band SDR input HDF file path	
viirs.svi02	VIIRS 375m I02 band SDR input HDF file path	
viirs.svi03	VIIRS 375m I03 band SDR input HDF file path	
viirs.svi04	VIIRS 375m I04 band SDR input HDF file path	
viirs.svi05	VIIRS 375m I05 band SDR input HDF file path	
viirs.gmtco	VIIRS M-Band Terrain-Corrected Geolocation input HDF file path	

Input File Labels	Description	Source
viirs.svm13	VIIRS 750m M13 band SDR input HDF file path	products for other locations and times are available for download at www.class.noaa.gov
viirs.ivcdb	VIIRS Calibrator Dual-Gain IP input HDF file path	

Output File Labels	Description	Output Format Description
viirs.activefires375	VIIRS 375m Active Fires output HDF file path	Please refer to the "vfire375_users_guide.pdf" document in the algorithm/docs/ directory within the VFIRE375_SPA package
viirs.fireloc375	VIIRS 375m Fire Location output text file path	

Execute the 'run': The following script shows an example of a command line to run the VFIRE375 algorithm from the testscripts directory:

```
$  ../wrapper/VFIRE375/run \
viirs.gitco ../testdata/input/GITCO_npp_d20140901_t1738560_e1740201_b14746_c20140908200715043541_noaa_ops.h5 \
viirs.svi01 ../testdata/input/SVI01_npp_d20140901_t1738560_e1740201_b14746_c20140908200814185302_noaa_ops.h5 \
viirs.svi02 ../testdata/input/SVI02_npp_d20140901_t1738560_e1740201_b14746_c20140908200817203819_noaa_ops.h5 \
viirs.svi03 ../testdata/input/SVI03_npp_d20140901_t1738560_e1740201_b14746_c20140908200743066611_noaa_ops.h5 \
viirs.svi04 ../testdata/input/SVI04_npp_d20140901_t1738560_e1740201_b14746_c20140908200756074531_noaa_ops.h5 \
viirs.svi05 ../testdata/input/SVI05_npp_d20140901_t1738560_e1740201_b14746_c20140908200946032012_noaa_ops.h5 \
viirs.gmtco ../testdata/input/GMTCO_npp_d20140901_t1738560_e1740201_b14746_c20140908200702642321_noaa_ops.h5 \
viirs.svm13 ../testdata/input/SVM13_npp_d20140901_t1738560_e1740201_b14746_c20140908200931364181_noaa_ops.h5 \
viirs.ivcdb ../testdata/input/IVCDB_npp_d20140901_t1738548_e1740201_b14746_c20161004162415456000_ipop_dev.h5 \
viirs.activefires375 ../testdata/output/VF375.hdf \
viirs.fireloc375 ../testdata/output/FireLoc375.txt
```

A successful execution usually requires 1 minute or more, depending on the speed of your computer and the size of the input. If execution fails, you will see an error message indicating the cause of failure (e.g., a file cannot be found, or a label cannot be recognized). Correct it and run again. If the problem has some other cause, it can be identified using the log files. Log files are automatically generated within the directory used for execution. They start with stdfile* and errfile* and can be deleted after execution. Other log and intermediate files may be generated automatically within the directory used for execution. They are useful for traceability and debugging purposes. However it is strongly recommended that users clean up log files and intermediate files left behind in the run directory before initiating a fresh execution of the SPA. Intermediate files from a previous run may affect a successive run and produce ambiguous results. The 'run' can be executed from any directory the user chooses. This can be done by prefixing it with the file path for the 'run' script.

NOTE: The data products generated by this SPA may be visualized with the DRL's H2G_SPA (Hierarchical Data Format [HDF] to Georeferenced Tagged Image File Format [GeoTIFF] Converter Science Processing Algorithm). H2G is designed specifically for Direct Readout

applications to create geolocated GeoTIFF images, jpeg browse images, and png browse images for parameter datasets in SNPP products and EOS products. H2G_SPA and its User Guide are available for download from the DRL Web Portal. Please refer to Appendix A for information on enabling image production for this SPA in IPOPP.

To Use the Scripts in the testscripts Directory

One simple way to run the algorithms from the directory of your choice using your own data is to copy the run_VFIRE375.sh script from the testscripts directory to the selected directory. Change the values of the variables like WRAPPERHOME, INPUTHOME and OUTPUTHOME to reflect the file paths of the wrapper directories and the input/output file paths. Then modify the input/output file name variables. Run the script to process your data.

Appendix A
SPA Services

Installation of this SPA in IPOPP mode will make the SPA services listed in Table A-1 available to IPOPP. These SPA services along with any other prerequisite SPA services (listed in Table A-2) will need to be enabled to allow IPOPP to automate production of the VFIRE375_SPA data products. The SPAs containing the prerequisite SPA services listed in Tables A-2 can be downloaded from the DRL Web Portal, in case they are not already available in your IPOPP installation. Details about these other SPAs are available in the respective SPA User's Guides. Please refer to the IPOPP User's Guide for instructions on how to install an SPA in IPOPP and enable the corresponding SPA services.

Table A-1. SPA Services

SPA services for this SPA	Data Products produced	
VFIRE375	**Product Name**	**Destination (when installed in IPOPP)**
	VIIRS 375m Active Fires	/raid/pub/gsfcdata/npp/viirs/level2/VF375_npp_d*yyyymmdd_thhmmssS_ehhmmssS**.hdf[1]
	VIIRS 375m Fire Location Text File	/raid/pub/gsfcdata/npp/viirs/level2/FireLoc375_npp_d*yyyymmdd_thhmmssS_ehhmmssS**.txt[1]

[1] Where *yyyy*, *mm*, *dd*, *hh* represents the year, month and day of month for the start of the swath; the first *hh*, *mm*, *ss*, *S* represents the hour, minutes, seconds and 10th of a second for the start of the swath and the second *hh*, *mm*, *ss*, *S* represents the end time of the swath.

Table A-2. Prerequisite SPA services

Prerequisite SPA services	SPA in which they are available
VIIRS_C-SDR or VIIRS-SDR	C-SDR_SPA VIIRS-SDR_SPA

NOTE: The SPA services VIIRS-SDR and VIIRS_C-SDR must never be run simultaneously.

Table A-3. Image-generating SPA services

Image-generating SPA services	SPA in which they are available
vfire375-geotiff	H2G_SPA

NOTE: Please refer to the H2G_SPA User's Guide for more details about the image products, including their locations and filename patterns when they are generated in IPOPP.